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PRESTRESSING PRACTICES IN BRIDGE BUILDING

by J. C. Rundlett

STRUCTURAL DIVISION

(Discussion open until November 1, 1955)

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THIS PAPER

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PRESTRESSING PRACTICES IN BRIDGE BUILDING

J. C. Rundlett[1]

Prestressing practices in bridge building at the present time are as variable as New England weather and as confusing to an engineer as a well-written contract. It is still not universally accepted by all engineers and some still consider it an experiment and plaything, but the record of achievements should dispel those opinions in any fair-minded man's mind.

With the rush that we are all faced with to get out plans, many engineers are loathe to take the time to design and detail prestressed beams when they can obtain the size of a steel beam with all its details in a matter of minutes. Many other engineers prefer to wait until methods are completely developed and the kinks are ironed out by others.

Most owners still require certified proofs of economy before they will approve prestressed designs, so that alternate bids are still being received on large jobs.

Prestressing can be termed commonplace now and as having reached the stage where papers on its growth are probably superfluous. In 1951, at the time of the first United States Conference on Prestressed Concrete, only a handful of structures were built and few contemplated. In 1952, at the Joint Meeting of the A.C.I. and A.S.C.E., I spoke with great pride on the tremendous accomplishments of the Massachusetts Department of Public Works in building its first prestressed bridge with a span of 27 feet. In 1954, over two hundred structures have been built, and, for examples, only a few can be selected to indicate prestressing progress and trends.

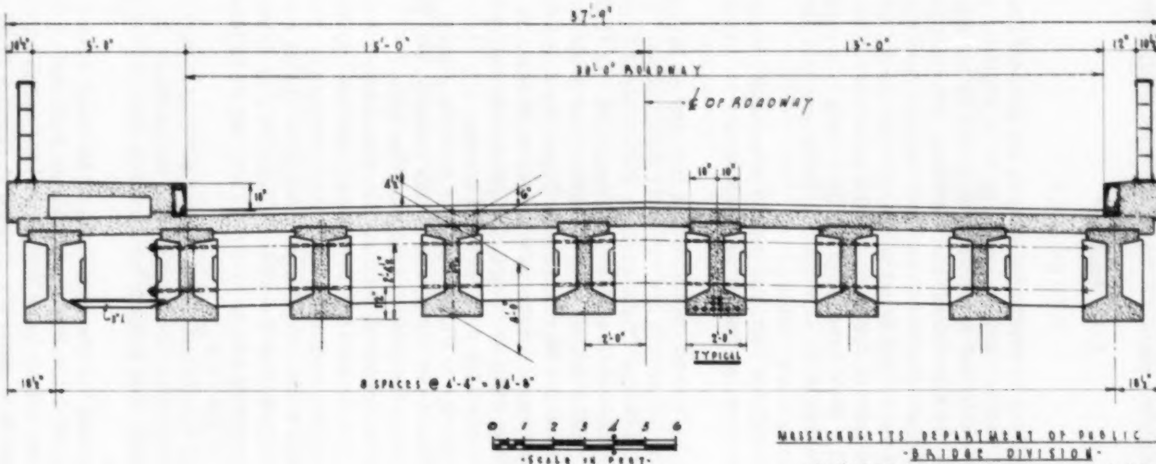
The Walnut Lane Bridge in Philadelphia is still the longest span prestressed bridge that has been completed in this country, and Tampa Bay Bridge in Florida is still the longest bridge of this type.

The trend has not yet turned to the long and gracefully arched sections prevalent in Europe, but instead has remained, with few exceptions, in the conservative span lengths, competing with steel stringers. Needless to say, because of the abundance and simplicity of design of rolled wide-flanged beams and the determination of the steel industry to give battle to this pale-faced intruder, prestressing has to gird its loins and go to mass production to stay permanently in the race.

Massachusetts has completed to date seven post-tensioned prestressed structures, all of which were manufactured in the yards of the New England Concrete Pipe Company, and in their construction has run the gamut of fear, fire, and frustration.

Our first contract was for the furnishing of 50 small beams of the inverted T-type for the bridge over the Boston and Maine Railroad in Danvers. The bottom flanges of these beams were butted, and the areas between and over the flanges were filled with concrete, making in effect a solid slab. The stressing units for each beam were three 0.6" diameter galvanized cables,

1. Bridge Engr., Massachusetts Dept. of Public Works.



SPANS VARY 60'-6 TO 65'-3"

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
-BRIDGE DIVISION-
NEWBURYPORT - HALE STREET BRIDGE
CROSS SECTION

FIG. 1

greased and wrapped in Sisal-Craft paper. The beams had a depth of 14", a width of flange of 12", and each weighed about 3,200 pounds. These beams were cast indoors, hauled over the road about 65 miles, and were all erected in one day.

The remaining six bridges were all of the I-type, post-tensioned and grouted and all but one had the same cross section. 144 beams were constructed for these six bridges, all from two basic sets of steel forms. Insofar as possible, the beams were standardized as to dimensions and details to allow for the re-use of the steel forms with but two slight alterations—one for depth—and all for length.

While the over-all length of beams varied, the distance center to center of diaphragms was made constant. The contractor submitted a turret-type detail for the diaphragm stubs which allowed a simple rotating of the sleeve and insert to fit the skew as it might vary with the various bridges.

Of particular interest are the four bridges built on the Newburyport Turnpike, each making use of a different type of stressing element. All the beams are of I-shape, and have a width of bottom flange of 24", a width of top flange of 20", and a web thickness of 6". Three have a depth of 3' and were designed for H-20 loading, while the fourth, the Scotland Road Bridge, has a depth of 3'-8" and was designed for H20-S16 loading. The general spacing of the beams is 4'-6", and the poured-in-place deck slab was made composite with the beam.

The Scotland Road Bridge, carrying the Pike over, has a span of 65' and contains 24 beams stressed by the Roebling method, with the steel furnished by the American Steel and Wire Company. Each beam was prestressed with three 1-9/16" strands, two straight and one parabolic.

The Hale Street Bridge, having two spans at 64' and containing 18 beams was stressed by the Freyssinet method. Each beam contained 10 prestressing elements of twelve 0.196" diameter wires.

The Storey Avenue Bridge, with two spans at 58', has 36 beams stressed by the Lee-McCall system, using four 1-1/8" straight bars and two 7/8" draped bars.

The Pine Hill Road Bridge, having two spans at 59', has 20 beams stressed by the Prestressed Concrete Corporation, button-head type, using twelve 6 wire units of 0.25" diameter wires.

The casting yard for these beams was about 40 miles from the bridge sites and all beams were hauled over the road. The contractor chose to fabricate these beams out-of-doors and set up two beds in his yard. These beds, with ample working space between and on each side, were enclosed with two 4' diameter concrete pipe side walls, over which a sectional wooden roof was placed with the ends enclosed with canvas. Practically all the work was done during the fall and winter months. High-early strength cement was used, and the beams were steam cured.

The contractor's average schedule for the first Scotland Road beams was about as follows: (assuming that one beam in the bed had been stressed and the other poured, and that both had been under steam the previous night)

At 7.30 A.M. the completed beam was lifted from its bed to the storage area; at about 8 o'clock the reinforcing cage, containing all the reinforcing and stressing units, which had been fabricated to one side, was lifted into place; and between 8 and 10 o'clock the side forms were removed from the poured beam, cleaned and set in place around the new cage; at about 10.30 a partial tension was applied to the two lower strands of the cast beam; at about 12 o'clock the new forms were completely set and the new beam poured

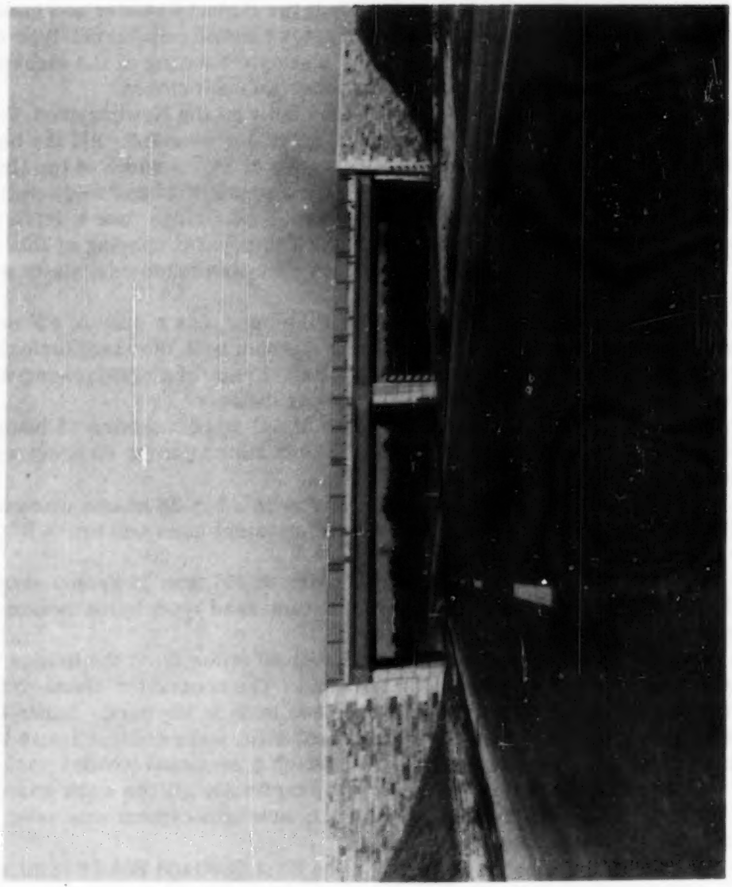


Illustration 1. Prestressed Bridge at Hale Street, Newburyport.

between 1 and 2.30 P.M.; and at about 1.30 the partially stressed beam was totally stressed if the test cylinder showed a 4,000-pound strength. Both beams were then covered and the steam applied for another night. Thus, the average beam was poured at about 1 P.M. and completely stressed at about 1.30 the next day, although it was kept in the bed for the second night of steaming.

Later, when another contract was let for a 67' bridge in Bridgewater, calling for 24 beams of the 36" depth section, another bed, which was to be used later for the testing, was constructed and another set of forms made. The schedule of operations for this project was much the same as that later utilized on the Garden State Parkway bridges.

Time and space do not allow the full detailed story of our work but a few should be noted.

All the beams for the Newbury-Newburyport project were grouted. While the original specifications did not so state, the contractor was allowed to use flexible metal hoses for enclosing the prestressing elements. For the 1-9/16" strand, a 2" diameter hose was used, for the 12 wires of the Hale Street Bridge a 1-1/4", for the 1-1/8" diameter and 7/8" diameter bars for the Storey Avenue Bridge a 1-3/4" and 1-1/2" respectively, and for the 6 wires of the Pine Hill Road Bridge a 1-1/4". All of the prestressing elements except the bars were shipped to the casting yard coiled in these hoses.

The success of the grouting operation is evidenced by the sections cut from the test beams after they had been destroyed. It seems almost incredible that the grout could penetrate and encase the individual wires as it did, but the picture is the proof. It would seem that a larger tube should have been used for the 1-9/16" strand, although the grouting was apparently successful.

In the early stages of prestressing, the need of grouting post-tensioned beams was questioned. Tests run on the Danvers project with two beams ungrouted and one grouted indicate that all the beams under load behaved in the same manner up to the point of cracking, but that beyond that point the grouted beam showed less deflection. Tests run at M.I T., as part of a co-operative project with the Department, on 0.6" diameter strands indicated that bond, achieved either by grouting or by tensioning the strands prior to casting and supplying and anchorage for the strands after release, increased the strand efficiency and ultimate moment by 20 per cent.

One very significant result of a later test on the Lee-McCall beam was the effectiveness of the bond between the bar and the grout. S. R. 4-strain gauges were attached to the four bottom bars near the end plate to measure the change in stress in these bars under the test load. These gauges indicated that there was no change in the stress in these bars at the nut until the load had reached the equivalent of about four live loads. At this point the stress in one bar started to increase, that in the others followed shortly, followed by the failure of the first bar through the root of the thread just inside the nut.

In my opinion, post-tensioned work should always be grouted if design details allow, because of its aid in strengthening the beams under excess loads and for the preservation of the stressing elements.

Fire

The prestressed bridge at Storey Avenue, stressed with Stressteel bars, was subjected to a severe fire on May 27, 1954, before the structure was

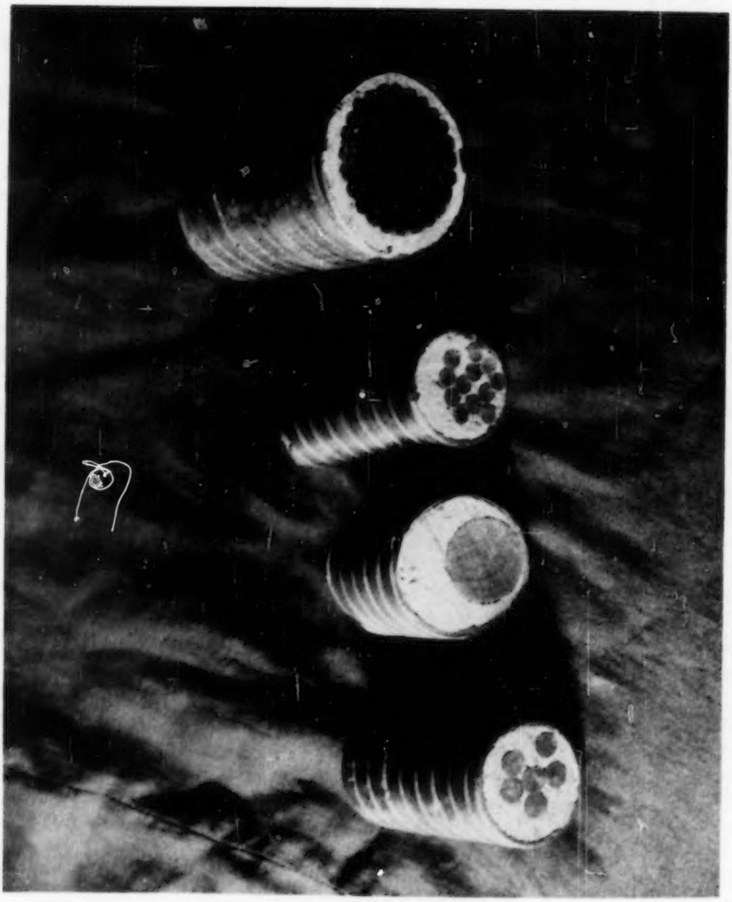


Illustration 2. Sections cut from Prestressing Elements on Newbury-Newburyport Project.

Illustration 3. Showing effects of fire on Storey Avenue Bridge in Newburyport.

completed. The roadway slabs had been poured and were open to traffic, but the center reservation of this double-barreled bridge was formed in but not poured.

The contractor had 300 bales of his mulching hay stored under the bridge in the center reservation, and at 4.45 in the morning firemen called to the bridge found a raging fire with flames being pulled up through the burning forms of the center reservation in flue fashion. The fire had been going for about 30 minutes. The only damage was the spalling of the pier and of the face of the prestressed beams in the reservation area where the heat was concentrated.

Subsequent load tests of two times the live load run on the damaged beams indicated that no damage had been done to the stressing elements and that the damage to the concrete was insignificant as the deflection of the beams was well within the calculated limits.

Beams on any bridge would undoubtedly never be subjected to a hotter or a longer fire.

The results of the fire at the Storey Avenue Bridge confirm a statement made by Mr. G. Baar, Director of the Fire Research Station at Elstree, England, before the First International Congress of the Internation Federation of Prestressing in October of 1953, that a 2" concrete cover and proper grouting provide adequate protection from fierce fires.

In order to present to you the many variations in the details of prestressed bridges I have selected some which I think are representative. In many cases the variations are slight but are worthy of note. Those examples will be classified into the fundamental groupings of Block, Pretensioning, Post-tensioning, Combination Tensioning and Continuous Construction.

Block Construction

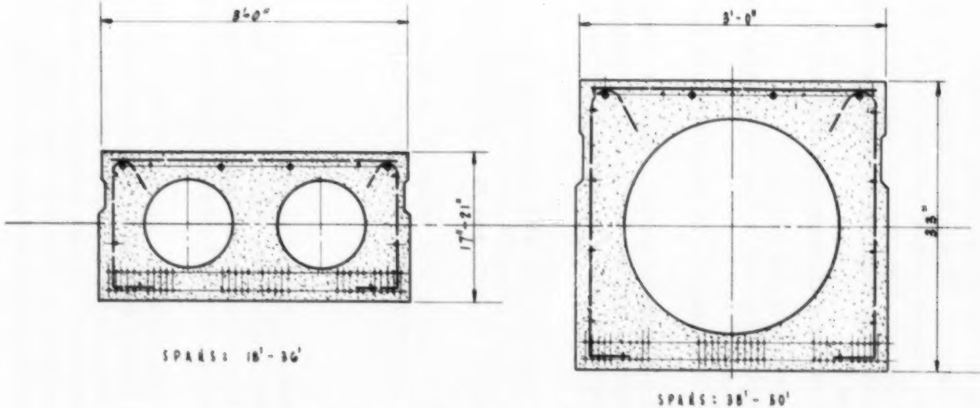
I believe that the first prestressed bridge in the United States that was open to travel was the Turkey Creek Bridge in Tennessee, designed by Bryan & Dozier and completed in October of 1950; and another and later one is the John R. Bridge, designed by Johnson and Anderson and built over the Red River Drain in Michigan in the Fall of 1951.

Both of these designers, in their search for economy, turned to cast-block construction with each block butted. Bryan & Dozier buttered each block with mortar, while Johnson & Anderson built up a lip on one block and filled the voids with grout. This type of work is post-tensioned with cables.

One excellent example of this type of construction is over Peytons Creek on Route 80 in Smith County, Tennessee. This bridge has four simple spans at 32 feet. There are 22 prestressed block beams in the cross section which are butted, and the space between the web and over the top is filled with poured-in-place concrete. The bridge was then transversely prestressed.

Even though these designs are probably the cheapest of any type, Mr. Bryan is continuing his search for lower costs by reducing the anchorage costs and is currently making designs for continuous spans under live load by using reinforcing steel in the slab over the supports.

Minnesota has completed its first prestressed bridge near Lake City using block construction. This structure has two 25' spans with a 14' width of deck.



▼TYPICAL PRETENSIONED BEAMS▼

MANUFACTURED BY CONCRETE PRODUCTS CO.
AT POTTSTOWN, PENNA.

FIG. 2

Pretensioned Construction

Pennsylvania

Everyone interested in prestressing is familiar with the work being done in Pennsylvania by the Concrete Products Company. This company was producing inverted precast channel-shaped units, conventionally reinforced, at the time the Walnut Lane Bridge was built, and at that time became interested in the prestressing of these or other units as a means of reducing the cost.

Accordingly, after studying the various methods, the Hoyer, or long-line method of pretensioning was adopted. This method consists of stretching wires or strands to the proper tension on long casting beds on which the forms for several beams have been placed. The concrete is placed and vibrated in the form, and after it has reached the required strength the wires are released and the units separated.

This method tends toward economy in these important ways:

1. The elimination of permanent end fittings.
2. Depending on the length of the bed, a number of units can be stressed in one jacking operation.
3. The fittings used for stressing can be reclaimed and re-used many times.
4. The units are butted when placed on the bridge sub-structure so that no poured slab is required, and the bridge can be opened to travel immediately after the grout, which is placed in the key between the units, has hardened.

The number of bridges in Pennsylvania with spans from 15 to 50 feet produced by this method is large, there being 16 precast and pretensioned in 1951; 31 precast and pretensioned in 1952; and 31 precast and pretensioned in 1953.

The beams used all have a 3' width. For spans 18' to 36' in length, beams 17" to 21" in depth are used, and for beams 38' to 50' in length, 33" depths are used.

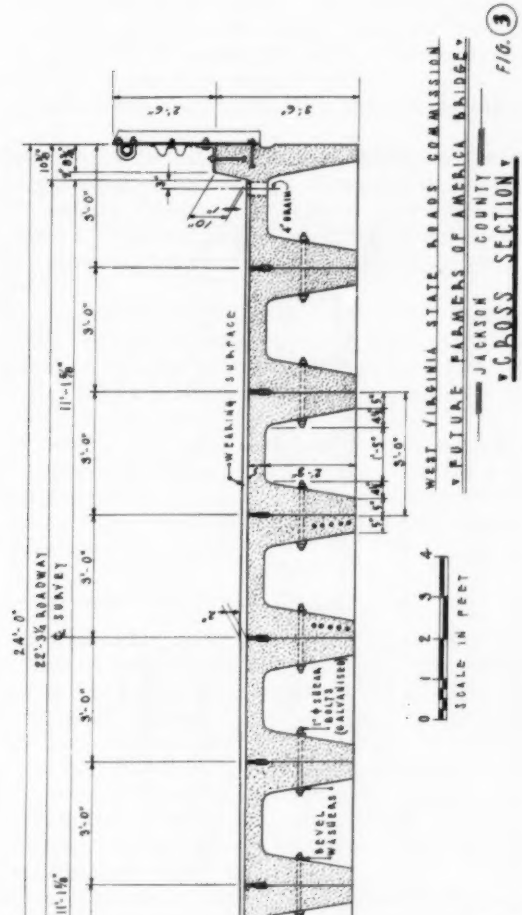
West Virginia

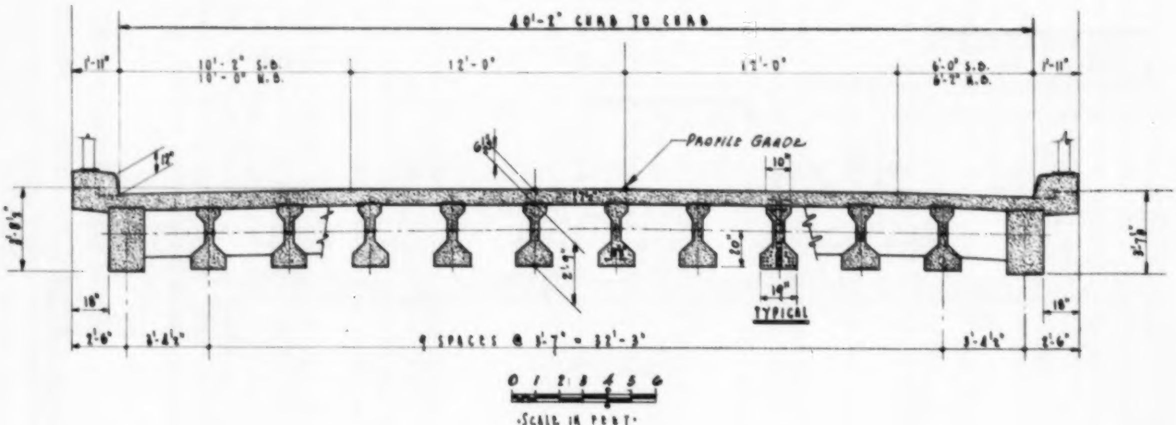
The West Virginia State Roads Commission completed its first pretensioned concrete bridge in 1953, located over Paint Creek in Kanawha County. This bridge was made up of three spans of 45 feet each and channel-shaped prestressed sections manufactured by the Universal Concrete Pipe Company were used.

Another structure of this type put under contract in West Virginia is the Future Farmers of America Bridge over Mill Creek near Ripley. This bridge has two spans at 65 feet, is designed for H-20-S16 loading and has a depth of only 2'-8". The width of section is 3'. These sections are butted and bolted together in place and are grouted at the keys and require only a bituminous concrete wearing surface to be placed before opening to traffic. The depth ratio is 1/25.

New Jersey - Garden State Parkway Bridges

Of recent interest is the prestressing work on the Garden State Parkway Bridge in New Jersey where the beams for twelve bridges were precast and prestressed. The exterior rectangular beams were post-tensioned, while the interior beams, of a modified I-section, were pretensioned.


WEST VIRGINIA STATE ROADS COMMISSION
FUTURE FARMERS OF AMERICA BRIDGE
JACKSON COUNTY
CROSS SECTION
FIG. 3
2 SPANS @ 65'
SCALE IN FEET
24'-0"
22'-3¼" ROADWAY
℄ SURVEY
WEARING SURFACE
BEVEL WASHERS
4" DRAIN



SPANS VARY: 39'-60'

NEW JERSEY HIGHWAY AUTHORITY
GARDEN STATE PARKWAY
"ZION ROAD BRIDGE"
"CROSS SECTION" FIG. 4

190 interior and 28 exterior beams having spans varying from 39' to 60'-4" were made of the same two basic cross sections, with the stressing elements varying according to the spans. The interior beams were all 33" deep with a 6" thick web, 12" wide top flange, and a 19" bottom flange. The exterior beams were all 33" deep and 16" wide. The depth of superstructure, including the poured-in-place slab, was 39-1/2".

The beams and slab were made composite under live load with shear keys and stirrups.

The original design for the exterior beams called for pretensioning, but in order to expedite the work they were post-tensioned in other beds, allowing the fabricator to make the exterior and interior beams simultaneously. Twenty-four to forty 3/8" strands were used for the pretensioned beams and 9 units of ten 1/4" diameter wires of the buttonhead type were used in the post-tensioned beams.

The beams were manufactured in three plants about 30 miles from the bridges. High-early strength cement was used, the concrete was steam cured and the beams cast in a two-day cycle. The procedure and timing are almost identical with the work done in Massachusetts. Gannett, Fleming, Couddry and Carpenter were the designers.

The Formigli Corporation, manufacturers of the Garden State beams, are now prepared to continue this type of manufacture, and the prices estimated by them for completed decks on spans up to 60' and within 150 miles of this plant certainly indicate that the cost of this type of construction has been reduced and is competitive with steel.

Louisiana - Lake Pontchartrain Bridge

One of the most interesting designs with a different approach is the Lake Pontchartrain Bridge on the Greater New Orleans Expressway in Louisiana.

About 24 miles of this bridge will be made up of a trestle-type structure having 56' spans and a 28' roadway. A typical span is composed of 7 modified I-shaped beams 4' deep with a 6-3/4" concrete slab. The 7 beams and the slab are to be precast monolithically as a pretensioned prestressed unit. The 5 interior beams are to be stressed with 35 5/16" diameter wire strands and the exterior with 33 5/16" diameter strands. The total weight of one span is approximately 180 tons and there are 2,237 spans which are to be supported on 54" prestressed concrete piles.

The designers are Palmer & Baker, Inc., of Mobile, Alabama.

Several tests of prestressed beams have been made for strength and fatigue, and the natural tendency to expand the size of beams, span lengths, and size of strands has been justified by these tests. The size of strands has gone from 1/4" to 5/16" and now to 3/8", with an occasional 7/16". Beams 36" deep are now being built with sixty-two 5/16" strands for stressing, and plans are being made for beams 42" deep for 70' spans.

Pretensioning is rapidly gaining in favor, and many other concrete products companies and concrete pipe companies are either manufacturing beams or are in the process of setting up yards.

Two examples of this are the Standard Prestressed Concrete Corp. of White Marsh, Maryland, who are furnishing pretensioned members of a modified I shape using 3/8" round strands for spans from 30' to 75' with depths from 24" to 36", and the New England Concrete Pipe Company, who have plans for producing rectangular hollow sections 4'-4" wide for spans of 50'.

Florida and Iowa have recently prepared standard plans for pretensioned work, both making use of the modified I-section.

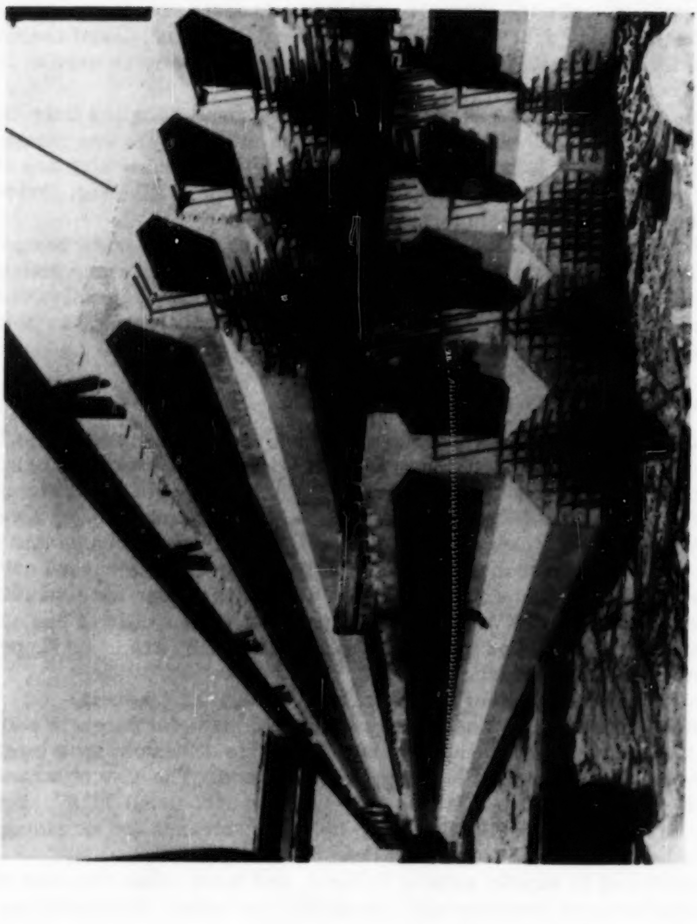
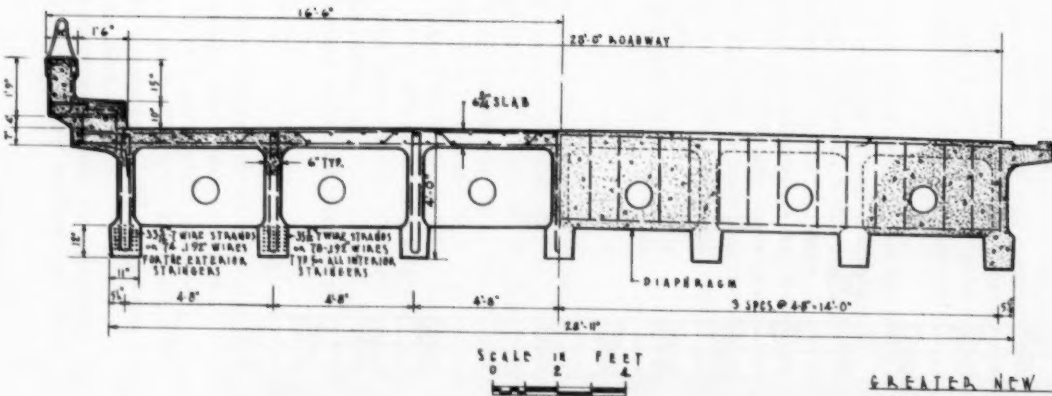
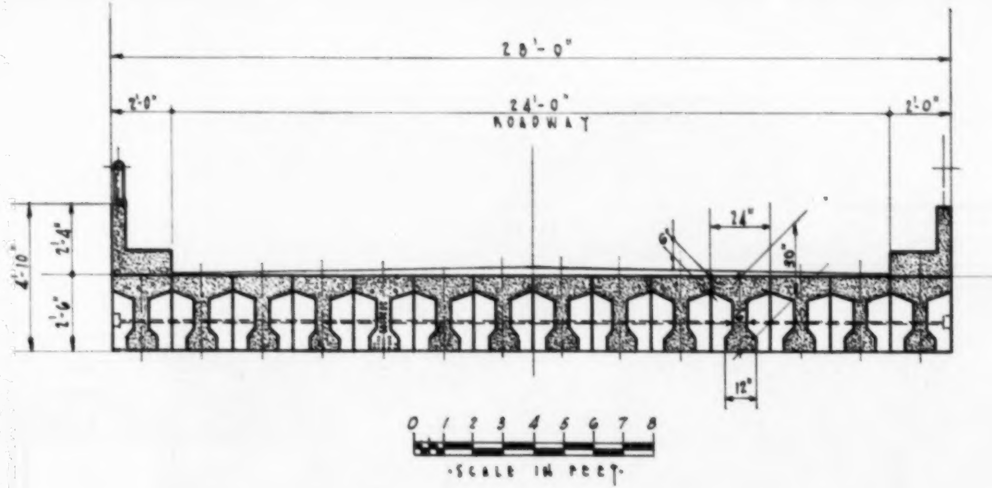


Illustration 4. Garden State Parkway Bridge Beams.



SPANS 56'

GREATER NEW ORLEANS EXPRESSWAY
LAKE PONTCHARTRAIN BRIDGE
LOUISIANA
"CROSS SECTION" FIG. 5



SPAN: 60'

·WHITE MARSH, MARYLAND·

▼STANDARD PRETENSIONED BEAM▼

FIG. 6

An indication of the success of this method and the seeming trend towards it is the recent announcement that the Freyssinet Company has designed a prestressing bench that can be adapted to turn out a variety of pretensioned concrete members and that they are licensing fabricators to set up prestressing yards using this design.

Post-tensioning

Florida - Tampa Bay Bridge

The Tampa Bay Bridge, part of a 15-mile causeway linking St. Petersburg and the West Coast of Florida, is the best example of the mass production of precast prestressed units which we have yet had in this country.

17,350 feet of trestle work was involved in this project, one section of 5,800 feet, and one of 10,900 were of a prestressed concrete design. The roadway width of this trestle is 28' and contains two 3' safety walks. There are six beams, I in shape, spaced 6' on centers in the cross section. These beams are 46'-10" long, 3'-4" deep, 14" wide and have a 4" web. They were post-tensioned with three 1" diameter Lee-McCall bars which were subsequently grouted.

Six casting beds, each large enough for the manufacture of 12 beams, were constructed on a spit of made ground projecting into Tampa Bay and were arranged for a continuous operation of casting and stressing. The beams were cast, the forms removed in one or two days, and transferred to another bed, and the beams stressed on the seventh day if the cylinder breaks indicated 4,000-pound concrete. 2,178 beams were cast in this manner, loaded onto barges, towed to the site, and transferred to the bents with a floating crane.

The slab was poured and the deck made composite for live load by the use of shear blocks and stirrups.

This structure has only recently been open to travel.

Colorado

One particularly interesting bridge has been built in Denver, Colorado, on West Mississippi Avenue on the Platte River. This structure, a concrete pile trestle, has four spans at 50' with a 40' roadway and two sidewalks.

The prestressed units have tapered sides, with a re-entrant seat cut for the slab, are 3' deep, 3'-6" wide and have a 21" economy hole in the center.

The beams are spaced 9'-3" on center. The slabs were precast and pretensioned, and finally the structure was laterally post-tensioned. The Freyssinet system was used and the members were cast at a plant about 12 miles from the bridge site. For this project, alternate bids received for prestressed vs. steel beams indicated a saving by the use of prestressing.

Connecticut

Connecticut's first prestressed bridge completed carries the Hartford-Glastonbury Expressway over Hubbard Street.

It has a span of 52'-6" and a width of 90'-8". There are 20 T-shaped beams on the section, each 2' 6-1/2" deep with a flange width of 30", a stem width of 15", and the beams are 4'-6" on centers. These are topped with a conventional concrete slab.

The superstructure contract was let separately and no specific system was designed, but the Freyssinet method was used.

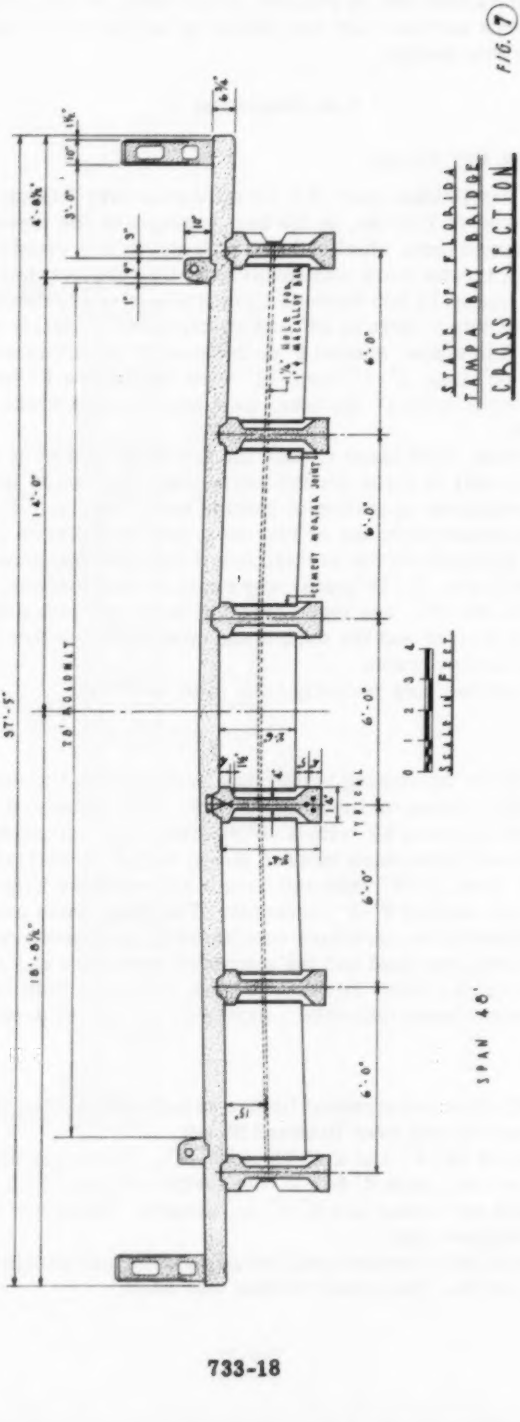
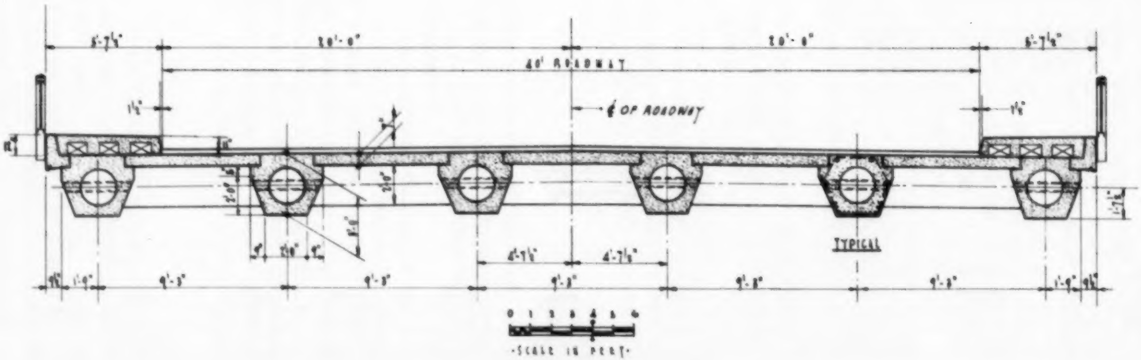


FIG. 7
STATE OF FLORIDA
TAMPA BAY BRIDGE
CROSS SECTION
SPAN 48'
Scale in Feet
0 1 2 3 4
37'-5"
28' ROADWAY
14'-0"
18'-8¾"
4'-8¾"
6'-0"
TYPICAL
CEMENT MORTAR JOINT



4 SPANS @ 50'-0"

CITY AND COUNTY OF DENVER

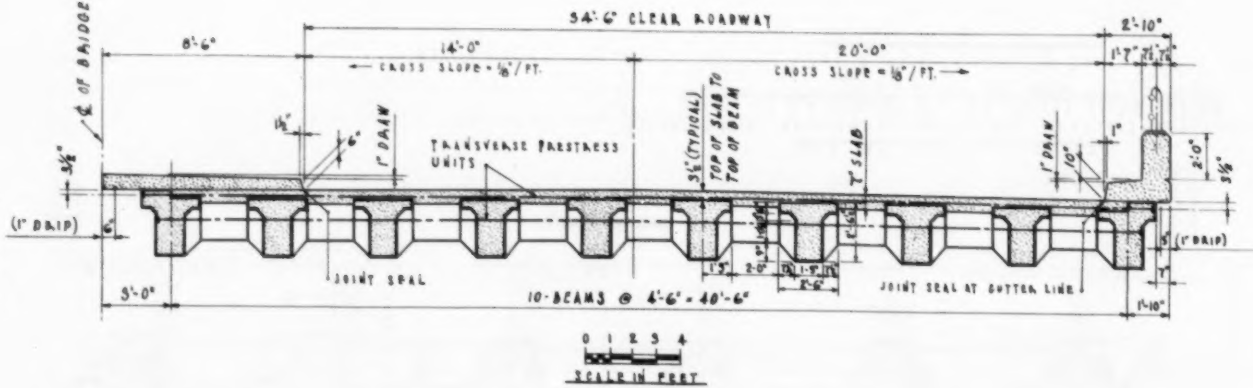
DEPARTMENT OF IMPROVEMENTS AND PARKS - ENGINEERING SECTION

BRIDGE AT W. MISSISSIPPI AVE. AND PLATTE RIVER DRIVE

·PROJECT NO. 941·

▾CROSS SECTION▾

FIG. 8



STATE OF CONNECTICUT

GLASTONBURY

HUBBARD STREET

HALF CROSS SECTION

SPAN 55'-6"

FIG. 9

Oregon

The prestressed concrete Willow Creek Bridge on the Columbus River Highway in Oregon was completed this past year. This structure, having three spans at 98' with provisions on the deck for a 30 roadway, is unusual in that the top flange formed a part of the roadway slab.

There are 5 modified I-shaped beams 96'-2" center to center of bearing and spaced 7' 2-3/4" in the deck. The beams are 5'-4" deep and have a 7" thick web. The bottom flange is 2'-2" wide and the top flange 4'-0" wide. The slab between the beam flanges was cast in place and the entire deck then laterally prestressed.

The specifications left the method of prestressing up to the contractor and he chose Freyssinet.

The girders in the two end spans were cast in place, and those for the central span were offset so that the jacking equipment could be used between the girders of the adjacent spans. The girders of the central span were then slid sideways into their permanent position.

Three other I-type prestressed bridges were put under contract in Oregon this past year, having spans of about 100', cast in place, and reinforced with the Strescon or button-head type wires. Oregon also has under construction a 97'-7" prestressed concrete box girder bridge, and a 131' box girder under contract.

Another prestressed bridge has been constructed by the Bureau of Public Roads on the Oregon Coast Highway over Ten Mile Creek, which has four 60' spans, four 45' spans and a 30' roadway.

There are 7 beams in the cross section spaced 5'-4" on center, of modified I-type, 3'-4" deep with a 16" bottom flange, an 18" top flange and a 6" web, and are composite with the slab under live load.

The type of prestressing was left open in the bidding and Stressteel bars were selected.

Maryland

A type where the top flange of the beam forms a part of the roadway slab is the Shawan Road Bridge on the Baltimore-Harrisburg Expressway in Maryland. It has a span of 100' with a roadway width of 30' and two safety walks, and spans the expressway.

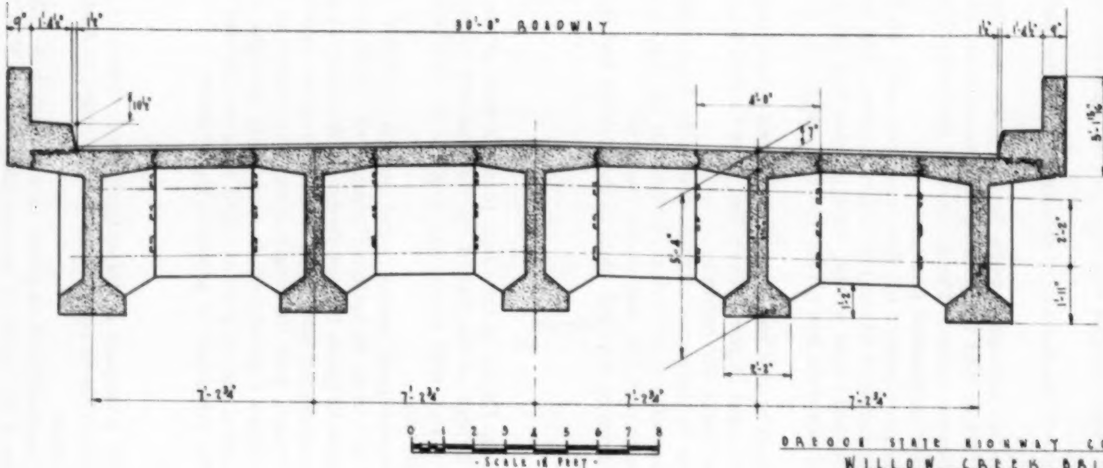
There are 9 post-tensioned beams in the section spaced 4' 1-1/4" on centers, 5' deep with a 20" width of bottom flange, 3'-8" width of top flange and an 8" web. The 5" slab between the top flange of the beam is poured in place and the structure prestressed laterally. The Freyssinet system was used.

This particular bridge, with its single span, was chosen as an experiment in contrast with two other conventional 3-span steel stringer bridges on the same project. The advantage of a clear open span was gained with a slight increase in cost. The structure is practically complete.

Kentucky

The Preston Street Overpass in Jefferson County, which is now under construction, is of similar type to the Shawan Road Bridge in Maryland. This structure has a 93' span.

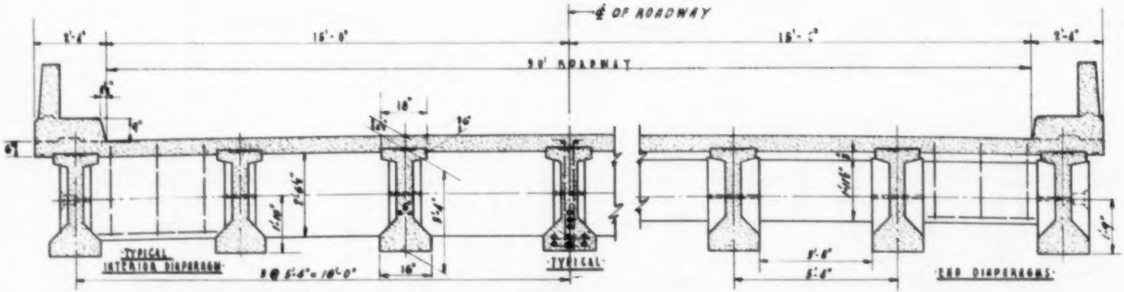
The beams, cast on falsework in place, are spaced 5' 4-1/2" on center, are 4'-10" deep, have a 20" width of bottom flange and a 3'-6" width of top flange, with the remainder of the slab poured in place. The diaphragms are prestressed but the slab is a conventional reinforced type.



SPAN 96'-2"

OREGON STATE HIGHWAY COMMISSION
WILLOW CREEK BRIDGE
COLUMBIA RIVER HIGHWAY
CROSS SECTION

FIG. 10



·SCALE IN FEET·

0 1 2 4 6

3 SPANS @ 90'

DEPARTMENT OF COMMERCE

BUREAU OF PUBLIC ROADS WESTERN HEADQUARTERS

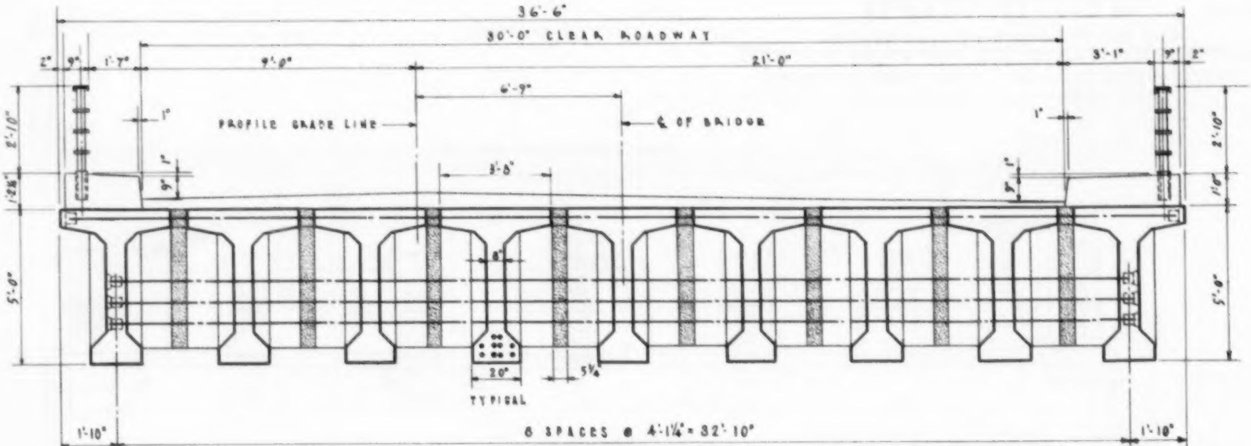
▼TEN MILE CREEK BRIDGE – OREGON COAST HIGHWAY▼

OREGON FOREST HIGHWAY PROJECT 9-A3

▼CROSS SECTION▼

FIG. 11

733-23



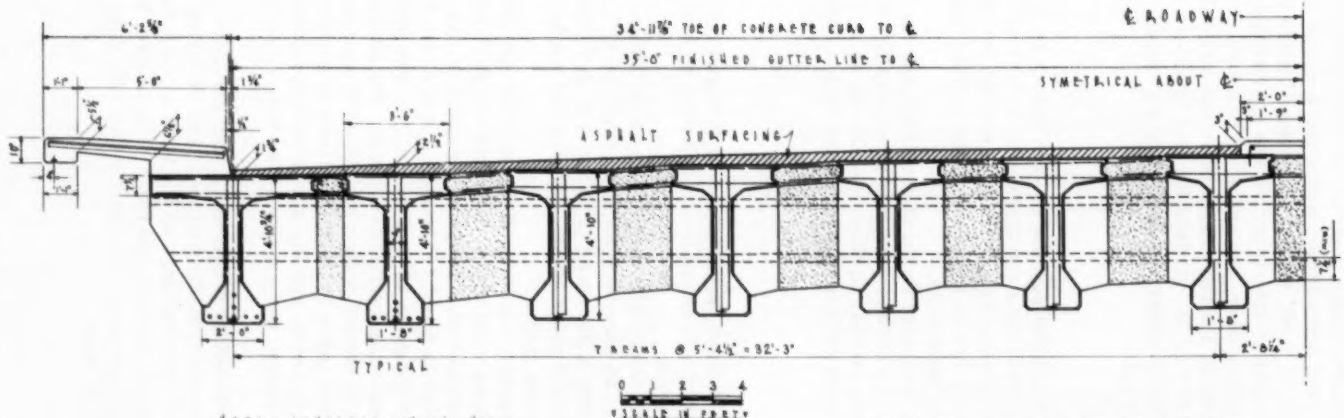
NOTE: CONCRETE SHOWN SHADED
TO BE CAST IN PLACE

SPAN 100'

0 1 2 3 4
SCALE IN FEET

BALTIMORE-HARRISBURG EXPRESSWAY
MARYLAND STATE ROADS COMMISSION
SHAWAN ROAD BRIDGE
CROSS SECTION

FIG. 12



NOTE: CONCRETE SHOWN SHADED TO BE CAST IN PLACE

SPAN 93'

KENTUCKY DEPARTMENT OF HIGHWAYS
JEFFERSON COUNTY
PRESTON STREET OVERPASS
HALF CROSS SECTION

FIG. 13

District of Columbia

The District of Columbia has under contract its first prestressed bridge, located on Atlantic Street over Oxon River, which has a single span of 74'-9", with provisions on the deck for a 40' roadway and two 6' sidewalks.

The nine prestressed beams in the structure are approximately square, 3' x 3'1-1/2", with a 24" hollow core, and are 6' on centers. A concrete deck is poured on the beams, making the total depth of super-structure 3'-10".

The contractor elected to cast the girders for this bridge in the vicinity of the project, and is now in the process of casting and stressing. The Freyssinet system is being used.

Iowa

Iowa's first prestressed project was the Allison Bridge in Butler County on a secondary road. It is a 30' span structure with a 20' roadway. The six interior precast post-tension units are 2'-8" wide and the two exterior beams are 3' wide. These members are of a channel shape, butted and prestressed laterally at each end and at the middle.

Since then the Concrete Products Corp. of Humboldt and the Prestressed Concrete Company of Iowa Falls have gone into prestressing, with the former making rectangular sections similar to those manufactured in Pennsylvania, and the latter developing inverted T-shaped sections with a conventional concrete floor slab.

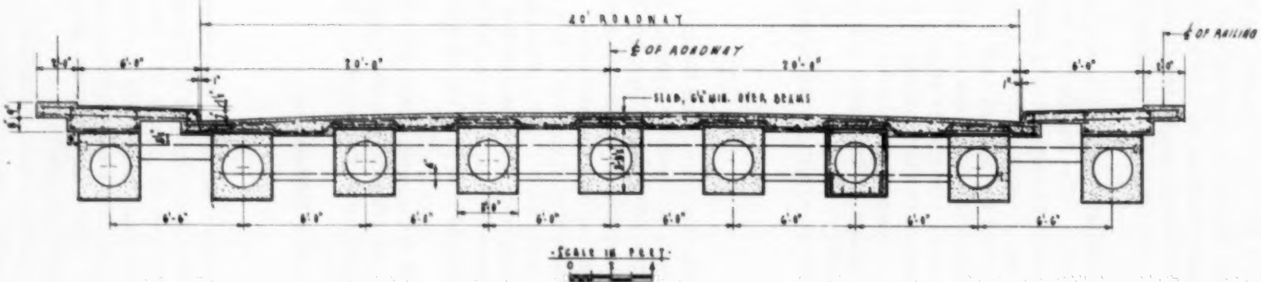
Wyoming County

The work by Mr. Felix Ramsey, Superintendent of Highways in Wyoming County, New York, is an excellent example of work done by the labor forces of a small political subdivision.

The first bridge constructed by Mr. Ramsey had a 62' span. Four beams, T in shape, were used, the two exteriors having a depth of 36", and the interior a depth of 33", both having a 30" width of flange and an 8" web. These beams were cast on the bridge seats as Mr. Ramsey did not have the equipment at his disposal to handle them.

The building of this structure encouraged him to proceed with a program of precasting girders in three sections, with the size of each unit limited by the capacity of his lifting equipment. These latter girders, the longest of which is about 52', were cast in about 17' lengths and are of a T-section with a depth of 3' and a width of flange of 30". Each section was poured against the other in the shop to insure a good fit in the field. The precasting of the sections was done indoors in the off season and they were stored until time for erection. The units were taken to the site, placed in position on the abutments and on two temporary bents, and the wires were threaded through the pipe sleeves, stressed, anchored and grouted. The Freyssinet system was used.

Mr. Ramsey is now constructing prestressed abutments for his bridges by casting the footing with the wires anchored into it and by laying up blocks 4' wide, 18" high and 6" thick, with two legs on the back of each block 8" thick where they join the slab and 6" thick at the back. The blocks, when laid up, are staggered, stressed and grouted. He reports that this is proving to be a very inexpensive abutment to build.



DEPARTMENT OF HIGHWAYS, DISTRICT OF COLUMBIA
BRIDGE DIVISION
•ATLANTIC STREET BRIDGE OVER OXON RUN•
•CROSS SECTION•

FIG. 14

California

The first prestressed bridge, built in 1950, in the west was the Arroyo Seco Footbridge in California, with a span of 110'.

The first prestressed vehicular bridge erected by the California Division of Highways was at Weber Avenue with a span of 67'. 10 beams of the modified I-section were required. The beams, cast about 150' from the bridge site, are 37" deep, have a top flange width of 36-1/2", and are butted.

From July 1953 to July 1954 California put under contract five prestressed bridges of box girder, T-section, and inverted T-section types, with spans varying from 46' to 115'.

One interesting design is the adaptation of California's conventional concrete box girder type to prestressing. The Big Dalton Wash Bridge near El Monte having one span 115' and designed for H20-S16 loading is an excellent example of this. This structure has a depth of 7'-3". The interior walls are 8" thick, the top slab 6-1/4" thick and the bottom slab 5-1/2" thick, and the stressing elements are in both the bottom slab and the walls. Under contract is a continuous structure of this same box girder type.

Bids have been received in California for a bridge at Richardson Bay having seventeen 79' spans. A typical span is composed of 15 precast beams 4'-4" deep with a 4'-6" wide top flange. The beams are spaced 6'-0" on centers and 18" of slab is cast in place.

On all California's work the plans permit any accepted method of prestressing.

Virginia, Hampton Roads

Of further recent interest is the Hampton Road Bridge in Virginia, a concrete pile trestle type structure with 80' and 50' spans. Alternate bids were received on October 8, 1954, for the 80' span calling for 261 post-tensioned beams versus steel stringer, and for the 50' spans, which contained 896 beams, pretensioned competed against post-tensioned.

For the 80' span, six 1-1/8" diameter Stressteel bars were indicated for a 4'-7" deep beam. For the 50' span, four 1-1/8" diameter bars were shown for post-tensioned beams, and thirty-six 3/8" strands for the pretensioned alternate. Both types of beams were 3' 7-1/2" deep, but the width and shape are larger for the prestressed alternate to provide ample space for the prestressing units.

24" prestressed concrete piles are specified for the bents.

Parsons, Brinckerhoff, Hall & MacDonald are the consultants.

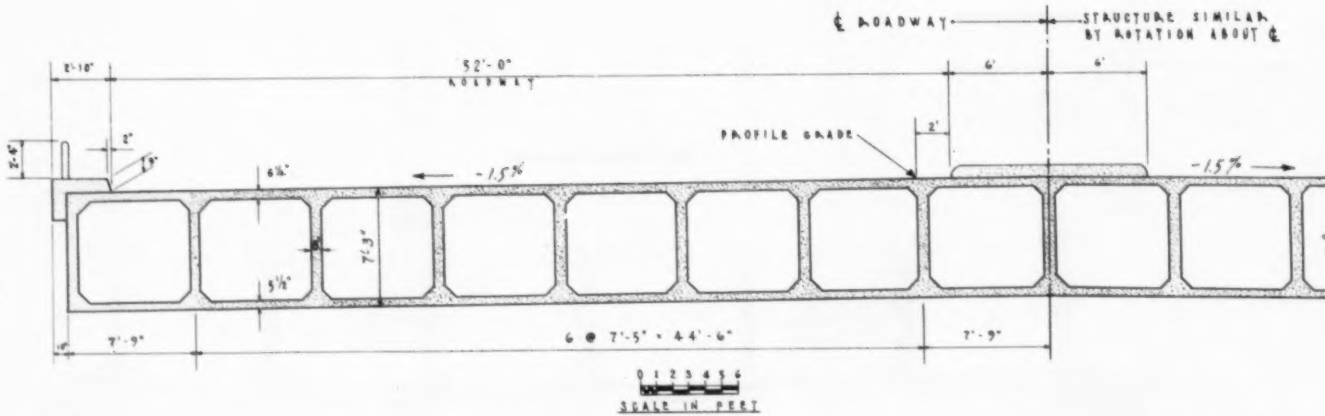
The low bid for the combined contracts was on the prestressed beams.

Combination Tensioning

Florida

Florida received bids on September 30, 1954, on a prestressed alternate design, for a bridge adjacent to the Gandy Bridge at Tampa Bay. This structure contains two hundred and fifty-two 48' spans with prestress construction being an alternate bid with conventional reinforced concrete T-beam spans. There are twenty 72' spans with prestress construction being bid as an alternate with I-beam spans. For the 1505 concrete piles, prestressed or ordinary reinforced types are the contractor's choice.

The plans for the prestressed girders also showed a typical section of an alternate type of prestressing in which pretensioned strands 7/16" in



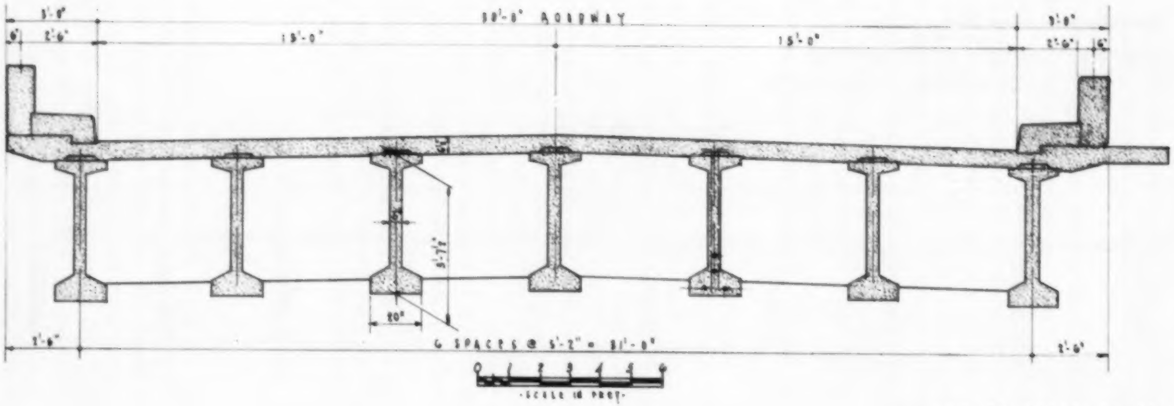
SPAN 115'

CALIFORNIA DEPARTMENT OF PUBLIC WORKS

BIG DALTON WASH BRIDGE

HALF CROSS SECTION

FIG. 15

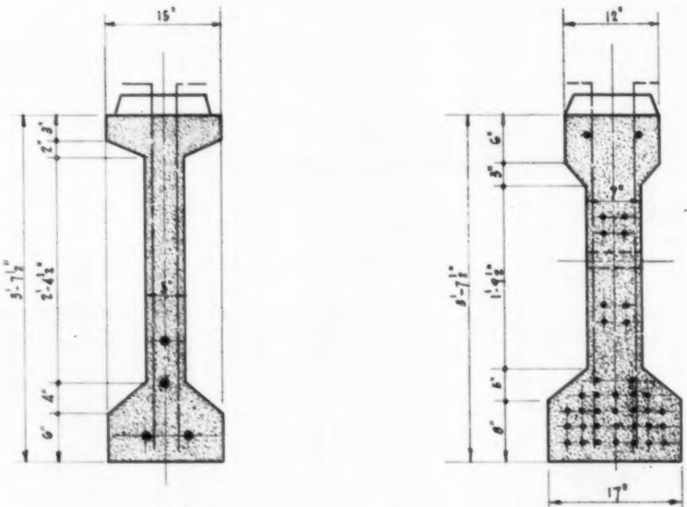


SPAN: 50'

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS
HAMPTON ROADS PROJECT

CROSS SECTION

FIG. 16



4-1⅛"ø
·POST TENSION·

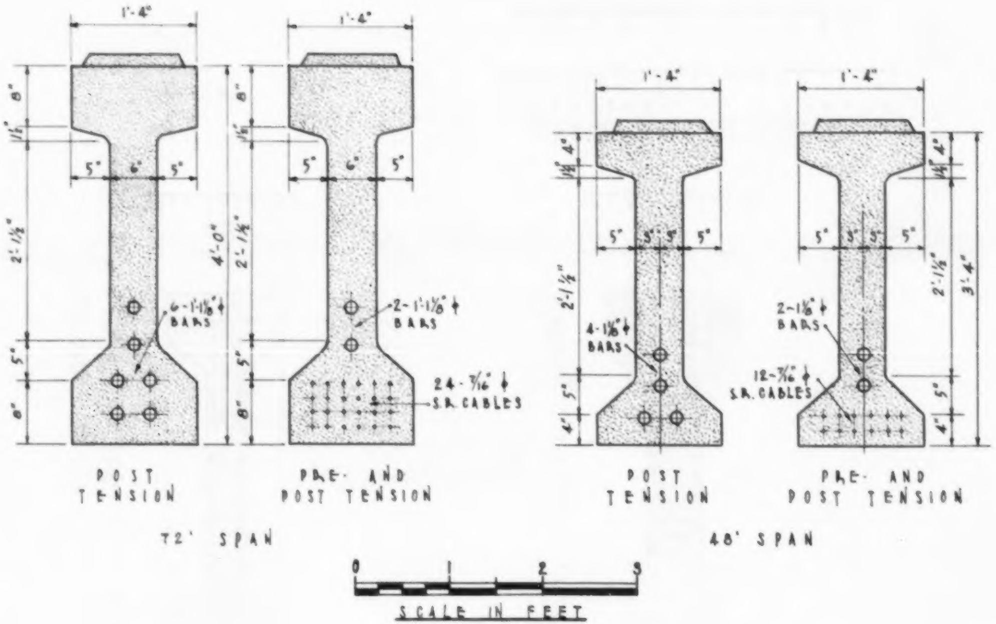
36-⅜"ø
·PRETENSION·

SPAN: 30'

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS
·HAMPTON ROADS PROJECT·

·BEAM SECTIONS·

FIG. 17



FLORIDA
TAMPA BAY - 1954 -
TYPICAL SECTIONS

FIG. 18

diameter are used for the straight reinforcement, with post-tensioned bars for the parabolic units.

The low bidder submitted no price for either the conventional or steel beams.

Florida now has four large prestressing yards scattered throughout the state and many more are in immediate prospect.

Every concrete pile job in Florida carries prestressed piles as an alternate to conventionally reinforced concrete piles, with the choice being left to the contractor. Prestressed piles are currently being used in about a dozen jobs. These piles are 12", 14", 18" and 20" square and are reinforced respectively with twelve 5/16", sixteen 3/8" and sixteen 7/16" diameter strands. The maximum lengths for these sections are 75', 85', 95', and 107'.

Continuous Structures

Texas, Houston

Several designs have been prepared for continuous prestressed structures. One under contract is the grade separation bridge at Waugh and Memorial Drive in Houston, Texas.

This structure, on a rather sharp curve, has four spans; two at 45', one at 65', and one at 70', the distance end to end of the prestressed slab being about 229'. There are provisions on the deck for two 35' roadways, a 4' median strip and two sidewalks. The entire structure is banked. It is a slab type about 24" thick with 58 stressing units in the section and with sonotube economy holes between each unit. Bids taken indicated that this is a very inexpensive deck. The design was prepared by Francis J. Nevin of Houston, Texas.

A similar design for the Furnace Brook Parkway on the Southeast Expressway in Massachusetts has been prepared by Preload Engineers, Inc.

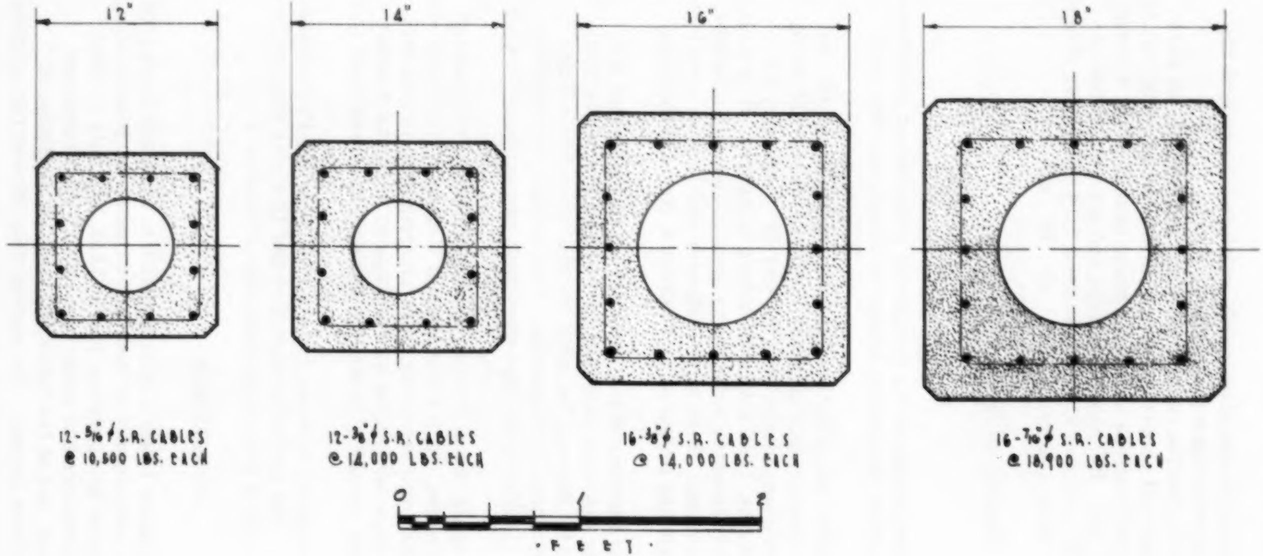
Other designs prepared by Preload included the 216' span Little Falls Bridge in Maryland for the Corps of Engineers. This bridge, stressed by the Leonhardt system, is similar to the type developed and extensively used in Germany.

Short counterweighted spans about 30' long extend in back of the bearing making the structure continuous. It is a box section 7' deep at the crown and 12' deep at the support. Only two stressing units are required, one in each side wall of the box. The stressing wires are continuous around a precast curved end block and all the stressing is done in one operation and from one end.

A study has also been made by Preload for a bridge over the Providence River in Providence, R. I. The proposed structure has 10 spans ranging from 100' to 120' in length and is of a box girder type with a depth of 4'.

CONCLUSION

In preparation for this paper I sent a questionnaire to all State Bridge Engineers to obtain an up-to-date survey of their activities in the prestressing field. Their replies indicated that between July 1, 1953, and July 1, 1954, eleven State Highway Departments had under contract 12 post-tensioned bridges and 85 pretensioned, and of the latter, 79 were in the States of Pennsylvania, Illinois and New Jersey. The survey also showed that sixteen departments had 91 prestressed bridges in the planning stage, 8 being post-tensioned and 83 pretensioned, and 74 of the latter were in the States of Pennsylvania, Illinois and Ohio.

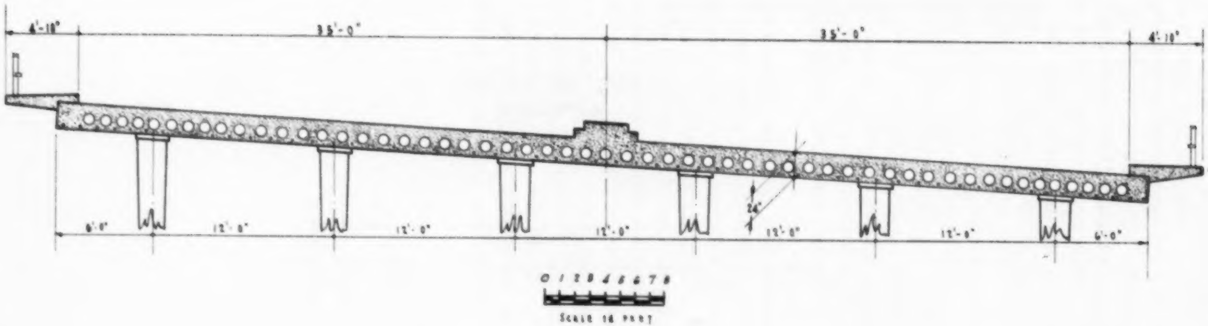


STATE ROAD DEPARTMENT OF FLORIDA

BRIDGE DIVISION

TYPICAL PRESTRESSED CONCRETE PILE DETAILS

FIG. 19



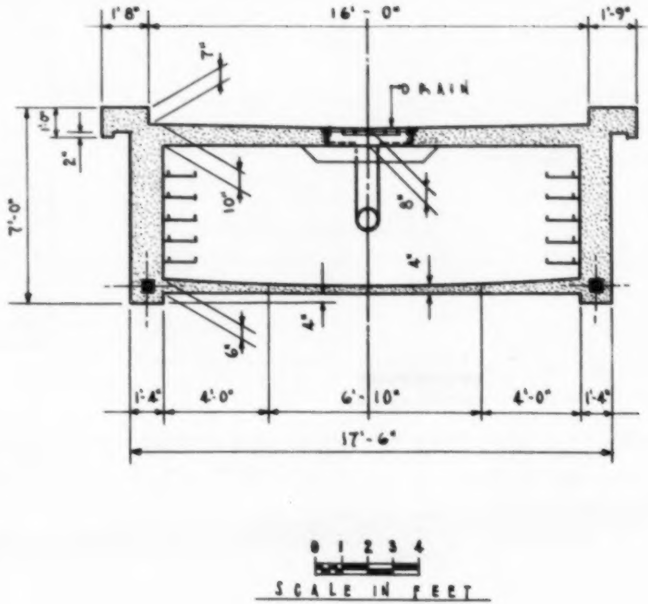
CONTINUOUS SPANS: 45'-70'-65'-45'

MEMORIAL DRIVE & WAUGH DRIVE

HOUSTON, TEXAS

CROSS SECTION

FIG. 20



LITTLE FALLS BRIDGE
CORPS OF ENGINEERS
MARYLAND

SPAN - 216'

"CROSS SECTION @ MIDSPAN"

FIG. 21

A similar questionnaire sent a year ago July revealed that the state highway departments had under contract, or had built to that date, a total of 104 prestressed bridges, 77 of these being in Pennsylvania. Summarizing, as of August 1, 1954, the state highway departments had constructed, or had under contract, about 200 prestressed bridges, and about 160 of these were pretensioned.

Replies from the Freyssinet Company, the Stressteel Corp., the Prestressed Concrete Corp., and the John A. Roebling's Sons Company indicated that many other structures have been built by county and local political subdivisions and by private companies and individuals.

The result of the recent questionnaire on prestressing sent out by the Engineering News Record gives a complete picture of this method of construction. My survey also indicates that the trend is to pretensioning in spans up to 70', which is about the limit for a beam that is to be cast in a distant yard and hauled to the bridge site. The use of continuity is lagging but its construction should show a reduction in costs.

In 1904 Massachusetts built its first reinforced concrete beam bridge; in 1930 its first wide-flange beam bridge; in 1931 its first long-span concrete rigid frame; in 1935 its first steel rigid frame; in 1943 its first composite steel and concrete; and in 1951 its first prestressed beam. All of these types have taken their rightful place in bridge engineering, some are used to a greater degree than others, but none have been superseded and are not likely to be.

You must be impressed, as I am, with the multitudinous sections used in precast beams. These sections generally fall into two classes, the square or rectangular section where the beams are butted when in place on the bridge requiring only a bituminous surface to be placed before opening the bridge to travel, and the other with the beams spaced, as steel beams would be, and with a poured-in-place concrete slab.

It is my suggestion that for the future the concrete interests attempt to standardize the sections in these two types, making the former similar to those produced in Pennsylvania, and the latter of a modified I-type similar to those used on the Garden State Parkway and now being standardized in Florida. Standardization will encourage the construction of more plants and will certainly lead to a far greater use of this product.